

**J2.6 TELECONNECTION OF THE 1997 EL NIÑO OBSERVED BY SPACEBASED SENSORS
AND THE DECADAL ANOMALIES IN THE NORTHEAST PACIFIC**

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1. OBSERVED POSSIBLE ENSO TELECONNECTION IN 1997

Liu et al. [1998] (hereafter referred as LTH), superimposed wind velocity anomalies observed by the NASA Satterometer (NSCAT) on the map of sea surface temperature (SST) anomalies observed by the Advanced Very High Resolution Radiometer (AVHRR) in the Pacific at the end of May 1997, and illustrated that the three regions of anomalous warming in the North Pacific Ocean are related to wind anomalies through different mechanisms. The anomalous warming along the equator is part of the El Niño condition and is related to the westerly wind anomalies and the relaxation of the trade-winds over the equatorial Pacific. The equatorial westerly wind anomalies are connected to the anomalous cyclonic wind pattern in the northeast Pacific. The anomalous warming along the west coast of the United States is the result of the movement of the pre-existing warm sea surface temperature (SST) anomalies with the cyclonic wind anomalies toward the coast. The warm SST anomalies are part of an anomalous SST dipole which has been present for more than a year in the Northeast Pacific. The dipole of SST anomalies is largely driven by anomalous surface heat flux. Winds coming from the tropical ocean bring heat and moisture; they suppress evaporative cooling. The associated clouds may also block solar heating. The opposite is true for winds from the north. Relatively weaker SST anomalies are also observed off the coast of Mexico. Under normal conditions, the subtropical high-pressure system off the Mexican coast, with northerly winds along

the shore, will cause off-shore Ekman transport and coastal upwelling of cold water. In 1997, the subtropical high was displaced by a low-pressure system and the associated southerly winds; coastal upwelling was suppressed and warm anomalies appeared. It was speculated that the mid-latitude SST variation is the results of ENSO modification of decadal changes.

2. DECADAL AND ENSO MODES IN SST

Empirical Orthogonal Function (EOF) analysis was performed on the interannual anomalies of SST, from January 1983 to July 1998. The first mode (Fig. 1), which has 33.7% of the variance show coherent variation along central and eastern equatorial Pacific, with large amplitude during known El Niño (1983, 1987, 1991-1992, 1993, 1995, and 1997) and La Niña (84-85, 88-89, 95-96) events. The fourth mode which has 5.0% of the variance (Fig. 2a), show coherent variation between a dipole (pattern of opposite phases) at 35°N and the equatorial variation. The equatorial variation is in phase with eastern part of the midlatitude dipole and the variation along the Mexican coast. The pattern is similar to the SST anomalies pattern in 1997 described in Section 1. The time series (Fig. 2b) show two events of large amplitude in opposite phases ten years apart, with a cold phase in 1987-1988 and a warm phase in 1996-1997. The SST variation was separated into El Niño and Southern Oscillation (ENSO) mode (2-7 years) and decadal mode (longer than 7 years), and the decadal mode (not shown) shows clear reversal of the east-west orientation of the mid-latitude dipole between 1994 and 1995. The midlatitude SST anomalies dipole reported by LTH is largely decadal variability while the equatorial variation is dominated by the ENSO mode.

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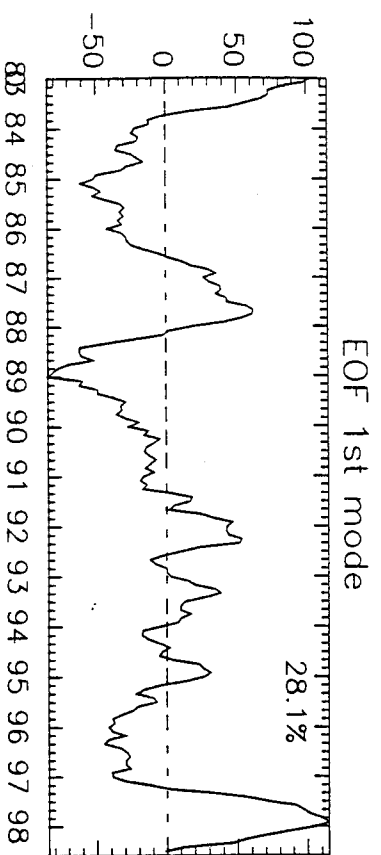


Figure 1a. Time series of the first mode of EOF on SST anomalies, it has 28.1% of the variance.

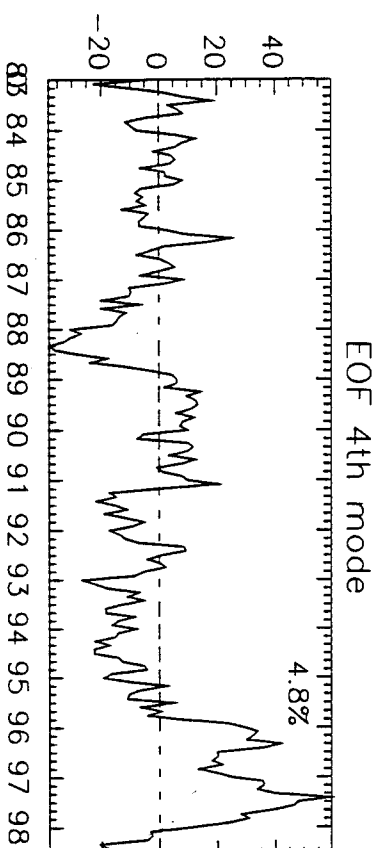


Figure 2a. Time series of the fourth mode of EOF on SST anomalies, it has 4.8% of the variance.

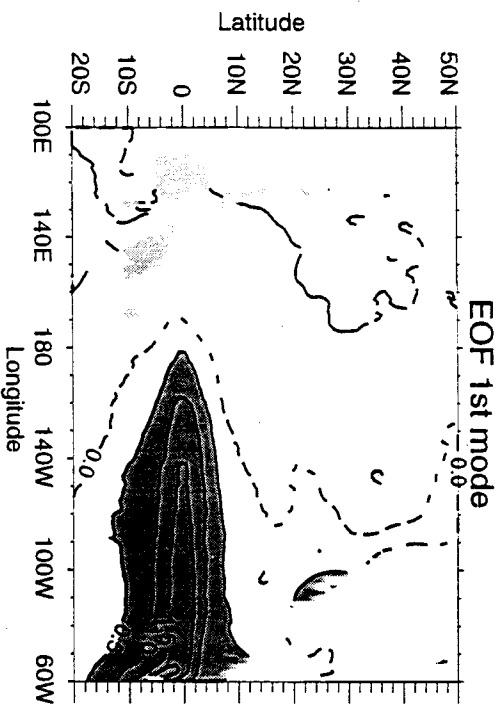


Figure 1b. Geophysical distribution of the first mode of EOF on SST anomalies. Positive values are indicated by the solid contours and negative values by dashed contours. The areas with values greater than 0.5 are shaded by dark gray, and those with values smaller than -0.5 are shaded by light gray. Contour interval is 0.5. The scale is 100.

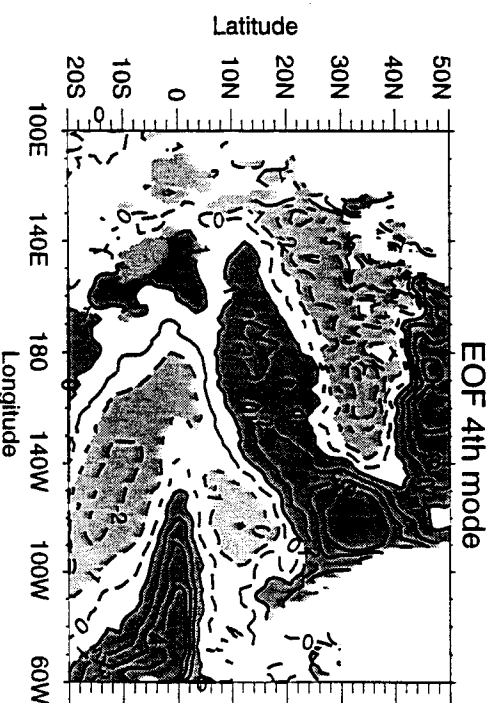


Figure 2b. Geophysical distribution of the fourth mode of EOF on SST anomalies. Positive values are indicated by the solid contours and negative values by dashed contours. The areas with values greater than 1 are shaded by dark gray, and those with values smaller than -1 are shaded by light gray. Contour interval is 0.5. The scale is 1000.

3. TIME SERIES OF RELEVANT PARAMETERS

The longitude-time section averaged between 30°N and 35°N (Fig. 3) for 1995-1997 clearly shows the dipole in SST anomalies, with the warm pole in the east and cool pole in the west. The magnitude and zonal movement corresponds to the meridional component of surface wind, with southerly wind in the west and northerly wind in the east, suggesting cyclonic circulation around a low pressure anomalies. The magnitude and zonal movement of the SST anomalies also agree with those of the surface humidity, with high humidity in the east and

low humidity in the west. The corresponding variations of the parameters support the postulation by LTH, that the SST dipole is driven by surface heat flux which, in turn, is caused by surface circulation as described in Section 1. The dipole patterns last through both the cool phase (1995-1996) and warm phase (1997) of equatorial anomalies. For the period of 1987-1988, the longitude-time section (Fig. 4) shows the opposite phase, with cold SST, northerly meridional winds, and lower humidity in east. The midlatitude SST dipole survives through the warm phase in 1987 and cold phase in 1988 of the equatorial anomalies.

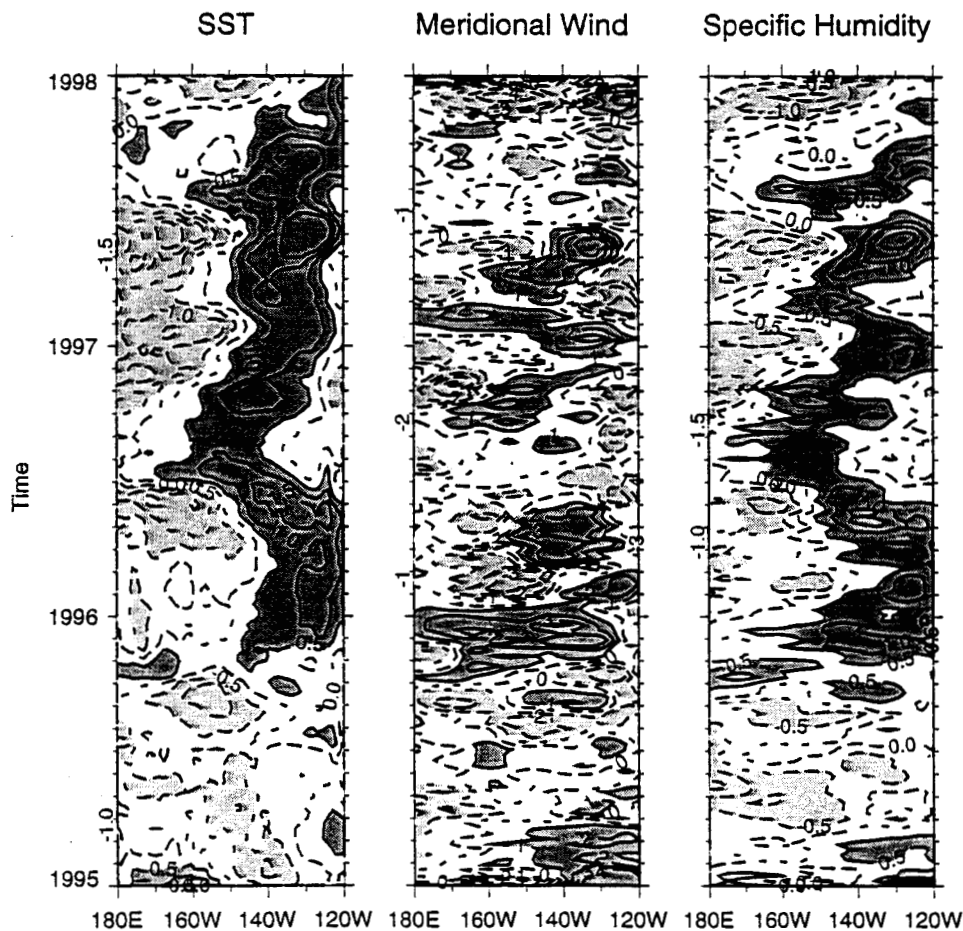


Figure 3. The longitude-time variations of SST (left panel), meridional component of surface wind (middle panel), and the surface specific humidity (right panel). Climatological annual cycles have been removed to form the interannual anomalies. Positive values are indicated by solid contours and the negative values by dashed contours. For the SST, the areas with positive anomalies greater than 0.5°C are shaded by dark gray, and those with negative anomalies smaller than -0.5°C are shaded by light gray. The contour interval is 0.5°C. For the meridional wind, the areas with positive anomalies greater than 1 m/s are shaded by dark gray, and those with negative anomalies smaller than -1 m/s are shaded by light gray. The contour interval is 1 m/s. For the surface specific humidity, the areas with positive anomalies greater than 0.5 g/kg are shaded by dark gray, and those with negative anomalies smaller than -0.5 g/kg are shaded by light gray. The contour interval is 0.5 g/kg.

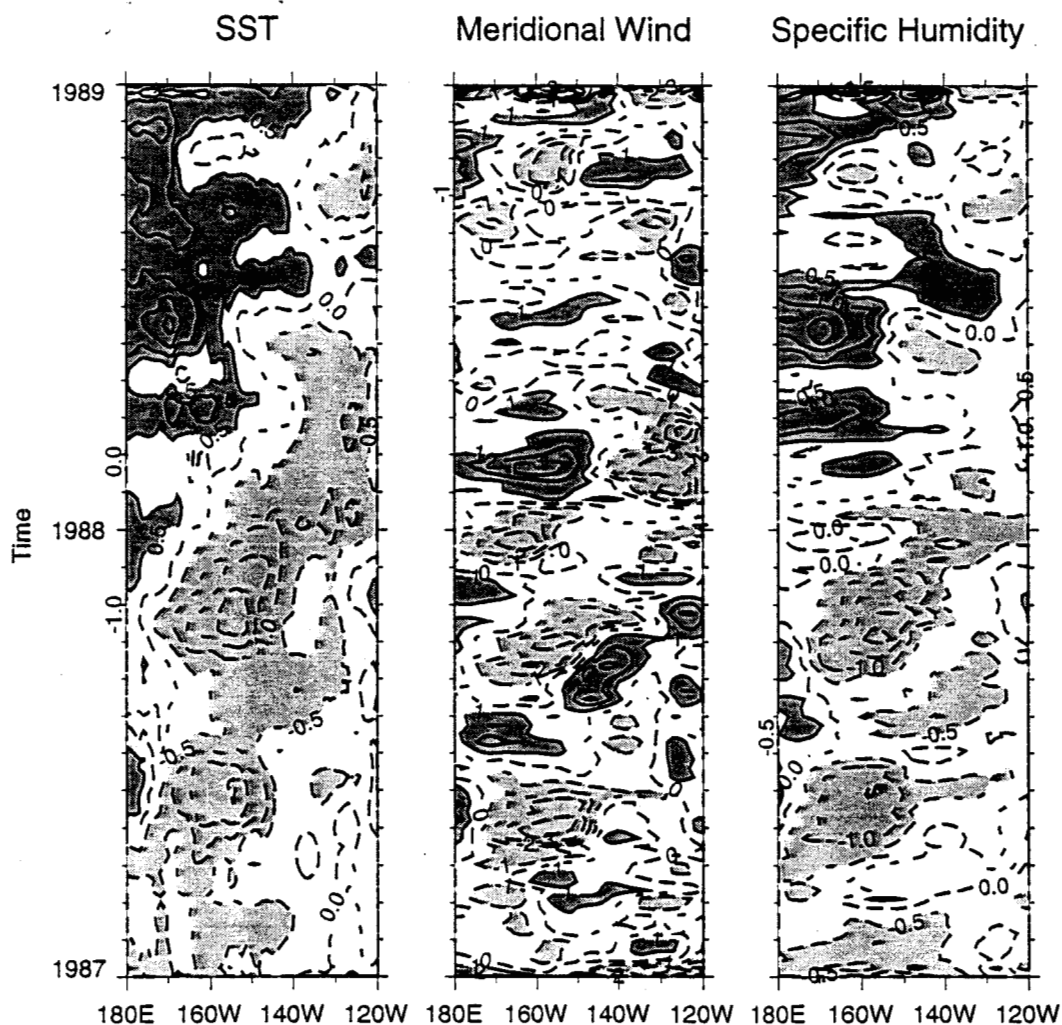


Figure 4. The same as the Fig. 3, except the time is from 1987 to 1988.

4. CONCLUSION

The SST anomalies in the Northeast Pacific are found to be largely decadal variations, and are, perhaps, modified ENSO. The east-west orientation of the anomalous SST dipole changes phase during the past decade. The dipole of SST anomalies is mainly caused by surface heat flux which is changed by atmospheric pressure system and the associated winds. The relation between equatorial SST and the mid-latitude pressure anomalies [e.g., Emery and Hamilton, 1985], and between ENSO and decadal variations are under vigorous investigation.

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